CLAIM + DETAILED DESCRIPTION

[Claim(s)]
[Claim 1]It is a pumping mode control-of-number-of-units device of pump equipment provided with two or more motor credit movable wings pumps which have movable wings into which a vane angle is changed, The number control device of driver's seats of a pump having a means to determine distribution of combination of an operation pump, and the amount of discharge of each pump which satisfies a preset value of the total amount of discharge, and from which electric power used serves as the minimum, based on a relation of the amount of discharge, an actual head, and electric power used which were beforehand found about each of said pump which exists two or more sets.
[Claim 2]A pumping mode control-of-number-of-units device of pump equipment provided with two or more motor credit movable wings pumps into which a vane angle of movable wings is changed characterized by comprising the following.
A memory measure which saves beforehand relation between the amount of discharge, an actual head, and electric power used about each of said pump which exists two or more sets.
. [a preset value of the total amount of discharge] An amount setting means of pump discharges to output combination of an operation pump and the amount of discharge of each pump from which electric power used serves as the minimum from the inside in quest of combination of an operation pump with which it is satisfied of this total amount of discharge from relation between the amount of discharge of each pump saved at the taking-in aforementioned memory measure, an actual head, and electric power used.

[Claim 3]In a method of controlling the number of a pumping mode of pump equipment provided with two or more motor credit movable wings pumps which can adjust a vane angle of movable wings according to a preset value of the total amount of discharge, It asks for relation between the amount of discharge, an actual head, and electric power used beforehand about each of said pump which exists two or more sets, A number control method of driver's seats of a pump setting up combination of an operation pump which searches for a total combination of an operation pump with which it is satisfied of a preset value of the total amount of discharge from said relation for which it asked beforehand, and with which electric power used serves as the minimum from the inside, and the amount of discharge of each pump.
[Claim 4]A number control method of driver's seats of a pump asking for relation between a net pump head and the amount of discharge, relation between brake shaft power and the amount of discharge, and

relation between motor efficiency and brake shaft power, and finding electric power used in each operating point of each pump about said each pump in Claim 3 based on these pump characteristics.

[Detailed Description of the Invention]
[0001]
[Industrial Application]In the pump equipment of a pump place or a drainage machine place which owns two or more motor credit movable wings pumps provided with the movable wings into which a vane angle is changed, this invention relates to the device and the control method of controlling the number of driver's seats of a pump according to the preset value of the total amount of discharge.
[0002]
[Description of the Prior Art]In the motor credit movable wings pump provided with the movable wings which can change a vane angle, since the amount of discharge changes by adjusting the vane angle, a pump can be operated in the target amount of discharge.
[0003]When there is the total amount of discharge which such a movable wings pump makes those with two or more sets and a target in pump equipment of a pump place or a drainage machine place, selection of the pump to operate and distribution of the amount of discharge of each pump are left to judgment of the operation member of a pump place.
[0004]Although there are some which are shown in JP,H5-18390,A or JP,58-93974,A as conventional technology which controls the number of driver's seats of a pump, with this invention, it is irrelevant.
[0005]
[Problem to be solved by the invention]How many kind thing combination is among the combination of an operation pump and distribution of the amount of discharge which satisfy the total amount of discharge made into a target. a maximum of 10 m^3/s for example, in operating by total amount [of 8 m] of discharge ^{3}/s, [at the pump place which owns two movable wings pumps which can be breathed out] Only the No. 1 pump is operated and it is 8m^3/s. Various correspondences of the operating method to pass, the operating method which is operated two sets and passed 4 m^3/s every respectively, etc. can be taken.
[0006]Although these judgment is conventionally left to the operation member, there is no standard special to the judgment, and experience has determined almost. However, even though it operates in the same total amount of discharge, depending on the operating method, it becomes inefficient operation.
[0007]With inefficient operation said here, the energy needed for performing the same output is large operation. Since the electric power used for the motor which drives a pump changes with operating methods when a pump is motor credit, if inefficient operation is performed, the electric power used will increase, and if efficient operation is performed, there will be little electric power used and it will end. That is, according to the example shown previously, even when operating by the same total amount [of 8 m] of discharge ^{3}/s, by the method of operating only the No. 1 pump by 8 m^3/s, and the method of operating by 4 m^3/s respectively two sets, I hear that the electric power to be used differs and it is.
[0008]In the pump equipment which owns two or more motor credit movable wings pumps, the purpose of this invention is to satisfy the total amount of discharge, to find the operating method which makes electric power used the minimum, and to control the pump to operate.
[0009]

[Means for solving problem]This invention asks for the relation between the amount of discharge, an actual head, and the electric power used beforehand about each of the pump which exists two or more sets, It is in setting up the distribution of the combination of an operation pump, and the amount of discharge of each pump from which total ****** and the electric power used serve as the minimum in the combination of the operation pump with which it is satisfied of the preset value of the total amount of discharge based on it.

[0010]The pumping mode control-of-number-of-units device of this invention is provided with the following.

The memory measure which saves beforehand the relation between the amount of discharge, an actual head, and the electric power used about each of the pump which exists two or more sets.

An amount setting means of pump discharges to output the combination of the operation pump with which the electric power used serves as the minimum from the relation between the amount of discharge of each pump which took in the preset value of the total amount of discharge, and was saved at said memory measure, an actual head, and the electric power used in quest of the operation combination of the pump with which it is satisfied of this total amount of discharge, and the amount of discharge of each pump.

[0011]In this invention, it is desirable to ask for the relation between a net pump head and the amount of discharge, the relation between brake shaft power and the amount of discharge, and the relation between motor efficiency and brake shaft power, and to find the electric power used in each operating point of each pump about each pump, based on these pump characteristics.

[0012]

[Function]The electric power used in each operating point of a motor credit movable wings pump is computable by asking for the relation between a net pump head and the amount of discharge, the relation between brake shaft power and the amount of discharge, and the relation between motor efficiency and brake shaft power. Here, an operating point means distribution of the amount of discharge of each pump. Electric power required for it is computable about any operating methods in the pump place by finding the electric power used in all the operating points about all the number of the motor credit movable wings pump installed in the pump place.

[0013]It can ask for the amount distribution of discharge of the combination of an operation pump, and each pump which can satisfy the set-up total amount of discharge by this, and can make electric power used the minimum easily.

[0014]

[Working example]One embodiment of this invention is described with reference to Drawings below.

[0015]Drawing 1 is an explanatory view showing briefly the number control device of driver's seats of the pump by this invention. The input means 1 from which this control device takes in the total amount preset value of discharge, and the memory measure 2 which saves beforehand the relation between the amount of discharge, an actual head, and the electric power used about each of the pump with which two or more sets are, It consists of combination of the operation pump with which the electric power used serves as the minimum from the inside in quest of a total combination of the operation pump with which it is satisfied of the total amount of discharge, and an amount setting means 3 of pump discharges to output the amount of discharge of each pump.

[0016]It is an aim of this invention which is distributed so that the electric power which uses the given

total amount preset value of discharge to each pump which exists two or more sets may serve as the minimum. Then, the calculating method of the electric power of a motor credit movable wings pump used is explained first.

[0017]The electric power used of a pump can use for and compute the curvilinear group which shows the pump characteristic.

[0018]Drawing 2 is the amount of net pump head-discharge curvilinear figure showing the relation between a net pump head and the amount of discharge. The curves 201-206 express the relation between the net pump head to vane angle $theta_1$ - $theta_6$, and the amount of discharge. The curves 208-210 are curves which are called a system head curve and express the relation between the resistance at the time of the discharge of a pump to actual head H_a - H_c, and the amount of discharge. Since the energy which takes the actual head said here to breathe out, so that at least the water by the side of the discharge of a pump and suction is a difference and a difference is as large as the water is needed, the amount of discharge becomes small. A net pump head is what added the resistance at the time of discharge like ****, and all the energies for a pump to breathe out water are shown.

[0019]Therefore, the operating point of the pump at the time of actual head H_b and vane angle $theta_O$ is a point shown by O, and the amount of discharge at that time is Q_O. By changing a vane angle between $theta_1$ - $theta_6$, the operating point of the pump at the time of actual head H_b moves in the curve 209 top. In the minimum vane angle, if $theta_6$ and the minimum actual head are made into H_a and the maximum actual head is made into H_c, the operation range of a pump will turn into [vane angle / $theta_1$ and / maximum] a range shown with the slash surrounded with the curve 201, the curve 206, the curve 208, and the curve 210 here.

[0020]It is necessary to find the electric power used in all the operating points of a pump in this invention.

Therefore, the electric power used in the operating point is found, changing an actual head and the amount of discharge little by little, and moving the operating point of a pump about the range in the slash of drawing 2.

Here, in quest of the electric power used about the operating point O on drawing 2, it explains below.

[0021]First, it asks for vane angle $theta_0$ of the pump in the operating point O. In drawing 2, about vane angle $theta_1$-$theta_6$, it is measured based on an examination, inspection method", etc. of a JIS B 8301"centrifugal pump, a mixed flow pump, and an axial flow pump at the time of the system performance testing in the factory of a pump, and the curves 201-206 are called for. Therefore, although they are known values, vane angle $theta_O$ at the time of the operating point O needs to ask for this first for an unknown value.

[0022]The operating point O is one of the states at the time of actual head H_b. Then, the amount of discharge in each vane angle is computed by asking for the intersection of the curves 201-206 and the curve 209 at the time of actual head H_b. Here, the amount of discharge to computed vane angle $theta_1$ - $theta_6$ is made into Q_1 - Q_6, respectively. The amount of discharge is taken along a horizontal axis, and a vane angle is taken along a vertical axis, and it will become drawing 3 if the relation between amount of

discharge Q_1 - Q_6, vane angle $theta_1$ - $theta_6$ computed by drawing 2 is expressed. The broken line 301 is a broken line showing the relation between the vane angle at the time of actual head H_b shown by the same actual head, i.e., drawing 2, and the amount of discharge. This broken line 301 can be used and it can ask for vane angle $theta_O$ in the operating point O.

[0023]Next, it asks for the brake shaft power in the operating point O. The amount curve of brake-shaft-power-discharge showing the brake shaft power of a pump and the relation of the amount of discharge which are shown in drawing 4 is used for it. The curves 401-406 of drawing 4 express the relation between the brake shaft power at the time of vane angle $theta_1$ - $theta_6$, and the amount of discharge. Since the amount of discharge at the time of vane angle $theta_1$ is Q_1, as for the brake shaft power at that time, the curve 401 and amount of discharge Q_1 show that it is P_1. Since it asks also about the curves 401-406 at the time of the system performance testing in a factory, the relation between the brake shaft power at the time of vane angles other than vane angle $theta_1$ - $theta_6$ and the amount of discharge is strange. Therefore, it will ask also for brake-shaft-power P_P in the operating point O by broken line approximation. The broken line 407 can be created brake-shaft-power P_2 at the time of brake-shaft-power P_1 at the time of vane angle $theta_1$ and amount of discharge Q_1, vane angle $theta_2$, and amount of discharge Q_2, and by asking for P_3 - P_6 similarly, and connecting the intersection of amount of discharge Q_1-Q_6, and brake-shaft-power P_1 - P_6. This broken line 407 is a broken line showing the amount of discharge and the relation of brake shaft power accompanying change of a vane angle. By this broken line 407 and amount of discharge Q_O, brake-shaft-power P_O in the operating point O is called for.

[0024]Finally, the electric power used in the operating point O is found. Brake-shaft-power P_O for which it asked in drawing 4 is power required for a pump to breathe out amount of discharge Q_O by vane angle $theta_O$. In order to give this brake-shaft-power P_O to a pump, what is necessary is just to give electric power how much to a motor, and it is related to motor efficiency. In brake shaft power, when P and motor efficiency are set to eta and electric power used is set to W, these relations are expressed by the following formula.

[0025]It turns out that what is necessary is for W=100x P/eta to get it blocked, and just to give an equivalent amount of electric power to brake shaft power if motor efficiency is 100%.

[0026]Here, the motor efficiency in the operating point O is needed. It can ask for it by the motor efficiency-shaft power curve showing the motor efficiency and the relation of brake shaft power which are shown in drawing 5. The curve 501 showing motor efficiency and the relation of brake shaft power and the intersection of brake-shaft-power P_O are motor efficiency eta_O in the operating point O. Used electric power W_O in the operating point O is computed by this motor efficiency eta_O and the above-mentioned formula.

[0027]By the above method, the electric power used is computed about all the operating points in the operation range shown in the slash part of drawing 1. It is performed about all the pumps of a pump place. It explains here using an example.

[0028]There is a pump place of 0.00 m of the minimum actual heads and 3.00 m of the maximum actual heads, and it is assumed that the pump of the following specification is installed.

[0029]The No. 1 pump Amount of maximum discharge 10.0m^3/s (at the time of the maximum actual head)

The No. 2 pump Amount of maximum discharge 10.0m^3/s (at the time of the maximum actual head)

The No. 3 pump Amount of maximum discharge 5.0m^3/s (at the time of the maximum actual head)

At this pump place, it is Table 1 which computed the electric power used about all the operating points of each pump.

[0030]

[Table 1]

表 1

吐出量 (m^3／S)	実揚程 (m)	1号ポンプ 翼角度 (°)	軸動力 (kW)	モ効率タ (%)	使電用力 (kW)	2号ポンプ 翼角度 (°)	軸動力 (kW)	モ効率タ (%)	使電用力 (kW)	3号ポンプ 翼角度 (°)	軸動力 (kW)	モ効率タ (%)	使電用力 (kW)
1.0	0	——	——	——	——	——	——	——	——	−20.0	30	88.0	34
	1.00	−20.0	80	89.6	89	−20.0	80	89.5	89	−19.3	40	88.8	45
	2.00	−18.5	120	91.0	132	−18.3	110	90.4	122	−18.2	50	89.4	56
	3.00	−16.7	150	92.1	163	−16.6	140	91.6	153	−17.0	60	90.0	67
2.0	0	−18.1	60	88.4	68	−18.0	50	88.0	57	−17.9	50	89.4	56
	1.00	−17.3	90	89.8	100	−17.1	80	89.5	89	−16.8	60	90.0	67
	2.00	−16.4	130	91.3	142	−16.2	120	90.9	132	−15.8	70	90.4	77
	3.00	−15.0	160	92.4	173	−14.9	150	92.0	163	−15.1	85	91.5	93
3.0	0	−16.2	70	89.2	78	−16.1	60	88.3	68	−15.7	65	90.2	72
	1.00	−15.3	100	90.1	111	−15.1	90	89.7	100	−14.8	70	90.4	77
	2.00	−14.6	140	91.7	153	−14.4	130	91.2	143	−13.5	85	91.5	93
	3.00	−13.5	170	92.8	183	−13.3	160	92.3	173	−11.1	120	92.8	129
4.0	0	−14.8	80	89.6	89	−14.6	70	89.1	79	−12.7	75	90.6	83
	1.00	−14.0	110	90.5	122	−13.8	100	90.0	111	−10.8	100	92.0	109
	2.00	−12.7	150	92.1	163	−12.5	140	91.6	152	−9.2	130	93.3	139
	3.00	−11.8	180	93.1	193	−11.6	170	92.7	183	−7.9	165	94.3	175
5.0	0	−13.1	90	89.8	100	−12.9	80	89.5	89	−9.1	100	92.0	109
	1.00	−12.6	130	91.3	142	−12.4	120	90.9	132	−6.3	135	93.5	144
	2.00	−11.9	170	92.8	183	−11.7	160	92.3	173	−3.2	170	94.4	180
	3.00	−9.8	230	94.4	244	−9.6	220	94.0	234	0	210	95.2	221

	3.00	−9.8	230	94.4	244	−9.6	220	94.0	234	0	210	95.2	221

[0031]That data is not contained in amount of discharge 1.0m^3/s of the No. 1 pump and the No. 2 pump and the column of 0 m of actual heads wants to be careful of one here.

[0032]This means that the amount of discharge exceeds 1.0 m^3/s also as the minimum vane angle, and a vane angle cannot be operated by 1.0 m^3/s at the time of 0 m of actual heads with the No. 1 pump of amount [of 10.0 m] of maximum discharge ^{3}/s, and the No. 2 pump. That is, it has separated from the range of the slash part of drawing 2, and becomes the outside of the object of calculation. What is necessary is to perform it only once, since the calculation result of this table 1 can be used unless the performance of a pump changes.

[0033]Thus, the operation pattern of the minimum use electric power can be found out by finding the electric power used of all the operating points about all the pumps in a pump place.

[0034]At the pump place shown in the above-mentioned example, if all the operation patterns with which it is satisfied of the total amount setup of discharge are selected when an actual head is 3.00 m and an operation member sets the total amount of discharge to 5 m^3/s, it will become as shown in Table 2.

[0035]

[Table 2]

表 2

No.	1号ポンプ 吐出量 (m^3/s)	1号ポンプ 使用電力 (kW)	2号ポンプ 吐出量 (m^3/s)	2号ポンプ 使用電力 (kW)	3号ポンプ 吐出量 (m^3/s)	3号ポンプ 使用電力 (kW)	使用電力合計 (kW)
1	0	0	5.0	234	0	0	234
2	0	0	4.0	183	1.0	67	250
3	0	0	3.0	173	2.0	93	266
4	0	0	2.0	163	3.0	129	292
5	0	0	1.0	153	4.0	175	328
6	0	0	0	0	5.0	221	221
7	1.0	163	4.0	183	0	0	346
8	1.0	163	3.0	173	1.0	67	403
9	1.0	163	2.0	163	2.0	93	419
10	1.0	163	1.0	153	3.0	129	445
11	1.0	163	0	0	4.0	175	338
12	2.0	173	3.0	173	0	0	346
13	2.0	173	2.0	163	1.0	67	403
14	2.0	173	1.0	153	2.0	93	419
15	2.0	173	0	0	3.0	129	302
16	3.0	183	2.0	163	0	0	346
17	3.0	183	1.0	153	1.0	67	403
18	3.0	183	0	0	2.0	93	276
19	4.0	193	1.0	153	0	0	346
20	4.0	193	0	0	1.0	67	260
21	5.0	244	0	0	0	0	244

[0036]Here, 21 kinds of operation patterns can be selected in all. In this table 2, the sum total of the electric power of all the pumps used is computed about all the operation patterns. And the electric power sum total used finds out the operation pattern used as the minimum. Table 2 shows that the operation pattern of No.6 is the minimum. That is, at the pump place shown in the above-mentioned example, when an actual head is 3.00 m and the total amount preset value of discharge is set up by 5 m^3/s, if only the No. 3 pump is operated by total amount [of 5 m] of discharge $^3/s$, the electric power used can be held down to the minimum.

[0037]Therefore, in such a case, the No. 3 pump is operated, and to it, it controls so that a vane angle shall be 0 degree by Table 1.

[0038]According to the procedure explained above, out of the operation pattern which computes the electric power used and with which it is satisfied of the set-up total amount of discharge, operation which makes electric power used the minimum can be performed because the electric power used

searches and controls the operating method used as the minimum.

[0039]Although how to take the operating point of explanation rough for convenience, as for Table 1 is adopted, when actually controlling, it is desirable to change the amount of discharge and an actual head in a finer unit, and to calculate. By doing so, the electric power used in the operating point near more nearly actual operation is obtained, and the optimal operating method can be found out.

[0040]

[Effect of the Invention]As explained above, at the pump place which owns two or more motor credit movable wings pumps, the combination of an operation pump and the distribution of the amount of discharge which make electric power used the minimum are found out and controlled by this invention out of the operation pattern suitable for the water level and the set-up total amount of discharge at that time.

Therefore, the employment expense (electricity bill) of a pump place can be reduced, without making an operation member conscious.

[Translation done.]